From Tomb Murals to Digital Narratives: A Spatio-Temporal Analysis of Ethnic Interaction Imagery in Ancient China

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ABSTRACT

The Silk Road served as a crucial corridor for the interaction, exchange, and integration of multiple ancient ethnic groups. As underground visual historical records, tomb murals authentically document the profound interactions among these groups in production, daily life, trade, ritual practices, and spiritual beliefs, serving as a precious visual archive that empirically evidences the formation of the Chinese national community. Focusing on ethnic images in tomb murals from the Han to Qing dynasties (202 BCE–1911 CE), this study introduces a digital humanities perspective to systematically investigate more than 406 archaeological sites by integrating spatiotemporal analysis, quantitative statistics, and iconological methods. Spatially, the ethnic images exhibit an uneven distribution—dense in the west and sparse in the east, and more prominent in the north than in the south—forming three major clusters centered in Shaanxi (high-ranking mural tombs of the Sui and Tang dynasties), Shandong (Han dynasty stone reliefs), and Inner Mongolia (murals of the Liao and Yuan dynasties). This pattern was jointly shaped by geopolitics, Silk Road trade networks, and regional funerary traditions. Temporally, these images underwent a continuous evolutionary process spanning over a millennium, characterized by the stages of "the gaze of the Other, assertion of power, symbiosis in daily life, institutional segregation, and reinforcement of identity". Furthermore, the study proposes that data-driven heritage exploration, coupled with intelligent digital exhibition and dissemination, can facilitate macro-level analysis of the images' evolutionary trajectory and longitudinally present the multi-layered content of the murals. This research not only provides systematized visual historical evidence for understanding mutual learning among multi-ethnic civilizations and the formation of the community, but also offers a practical paradigm for the digital interpretation and international dissemination of Silk Road cultural heritage globally.

Keywords: *Silk Road, Tomb murals, Ethnic images, Digital humanities, Spatiotemporal analysis, Cultural heritage.*

1. INTRODUCTION

The interaction and integration of multi-ethnic cultures across regions have been pivotal forces driving the evolution of human civilization and social progress. As underground visual historical records, Chinese tomb murals, guided by the funerary concept of "treating the dead as if they were living", authentically document the modes of production, daily life, and spiritual beliefs of various ethnic groups formed through their interaction, exchange, and integration throughout history. They serve as a precious visual archive for studying the formation of the pluralistic and integrated pattern of the Chinese nation. Spanning over a millennium, ethnic images in tomb murals depict a wide array of themes: from the integration of the Hu and Han peoples in the Han dynasty, to the caravans of foreign merchants, musical and dance performances, and acrobatics along the Silk Road during the Northern, Sui, and Tang dynasties, and further to the scenes of co-residence and integration among various ethnic groups from the Song and Yuan dynasties onwards. These images encompass both secular life — such as banquets, travels, farming, and trade—and religious beliefs,

including ascension to immortality and auspicious beasts, thereby constituting a visual chronicle of ethnic interaction engraved within the funerary space.

However, traditional research has largely focused on isolated case studies or specific regions, lacking holistic, long-term, and cross-regional quantitative analysis. By introducing a digital humanities perspective, this study conducts a spatiotemporal analysis of ethnic images in tomb murals from the Han to the Qing dynasties and explores transformation strategies based on digital narratives. This approach offers a novel pathway for presenting these cultural assets to the international academic community and advancing their digital transformation.

2. DATA CONSTRUCTION AND OVERVIEW OF IMAGE REMAINS: DATA SOURCES AND CLASSIFICATION

There are currently 1,290 known tomb mural sites in China (Wang, Xiaoyang, 2024, p208-299; Wang, Xiaoyang. 2023).[1] From these, we identified 406 sites that explicitly contain imagery depicting multi-ethnic integration (Jing Han, 2024, PI).[2] ("Table 1"). These remains encompass image data associated with 29 ancient ethnic groups, such as the Hu, Sogdians, Xianbei, Tubo, and Dangxiang. Regarding the types of image carriers, the images within the tombs are typically painted or carved on stone reliefs, the four walls of the tomb chambers, brick reliefs, and coffin panels ("Table 1").

Table 1. Types of image carriers and representative sites with ethnic imagery in murals

Type of Image Carrier	Representative Site	Represented Ethnic Group(s)	Murals with Ethnic Imagery
Stone Relief	Han Dynasty Pictorial Stone Tomb No. 23 at Dabaodang, Shenmu, Shaanxi ("Figure 1") 陕西神木大保当第 23 号墓汉画像石墓	Hu, Xiongnu 胡人 匈奴	 Figure 1 Xiongnu, Han Dynasty Pictorial Stone Tomb No. 23 at Dabaodang, Shenmu, Shaanxi.[3]
Tomb Mural	Northern Qi Dynasty Mural Tomb of Xu Xianxiu, Taiyuan, Shanxi ("Figure 2")山西太原北齐徐显秀壁画墓（图 2）	Xianbei 鲜卑	 Figure 2 Xianbei, Northern Qi Dynasty Mural Tomb of Xu Xianxiu, Taiyuan, Shanxi.[4]

Type of Image Carrier	Representative Site	Represented Ethnic Group(s)	
Brick Relief	Pictorial Bricks at Xincheng, Jiayuguan ("Figure 3" "Figure 4") Wei-Jin Tomb No. 7 at Xigoucun, Jiuquan, Gansu 嘉峪关新城画像砖（图 3、4） 羌人 甘肃酒泉西沟村魏晋 M7 号墓	羌 氐 龟兹 Qiang,Di, Kucheans	 Figure 3 Di people, Pictorial Brick Tomb No. 5 at Xincheng, Jiayuguan.[5]  Figure 4 Qiang people, Wei-Jin Tomb No. 7 at Xigoucun, Jiuquan, Gansu.[6]
Coffin Panel Painting	Side Panels 1 and 2 collected in Dulan County, currently housed in the Qinghai Provincial Museum ("Figure 5") 都兰县采集侧板 1 侧板 2 现藏于青海省博物馆（图 5）	Tubo， Dangxiang 吐蕃，党项	 Figure 5 Tubo, wooden coffin side panels 1 and 2 collected in Dulan County, currently housed in the Qinghai Provincial Museum.[7]

3. SPATIO-TEMPORAL ANALYSIS: DIACHRONIC EVOLUTION AND SPATIAL DISTRIBUTION OF ETHNIC INTERACTION

3.1 Regional Concentration and Heterogeneity of Spatial Distribution

Statistical data reveals that the imagery of multi-ethnic integration in tomb murals exhibits a distinct non-equilibrium, characterized as "dense in the west and sparse in the east, and heavy in the north and light in the south." The Northwest region possesses the highest number of surviving sites (140), followed closely by the Central region (132). The Northeast region forms a secondary cluster, dominated by Inner Mongolia (65 sites), while the Southwest (15 sites) and Eastern regions show a scattered distribution. This geographical disparity is not a result of the natural attenuation of artistic dissemination, but rather stems from three underlying factors: geopolitics, the Silk Road trade network, and regional funerary traditions.("Figure 6")

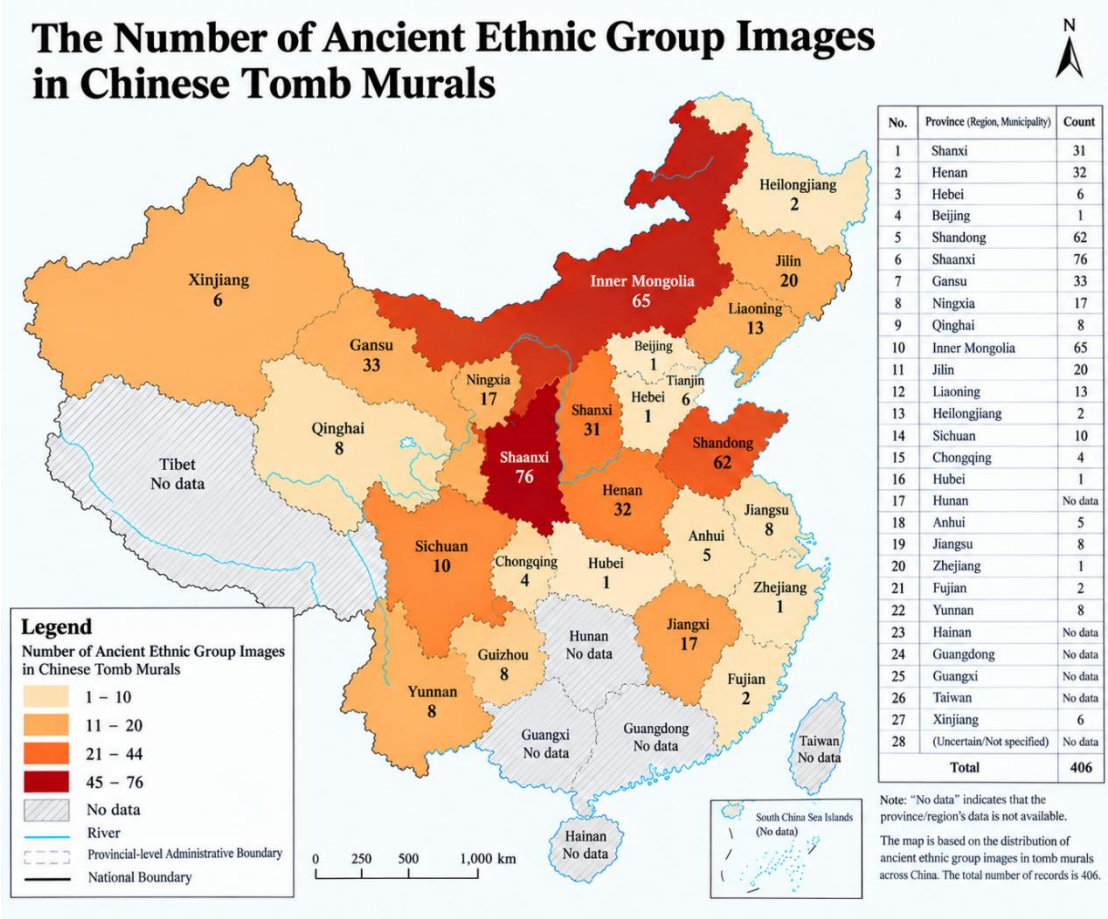


Figure 6 The number of ancient ethnic group images in Chinese tomb murals.

3.2 The Northwest Region: Dual Drivers of Politics and Commerce

Shaanxi leads with 76 surviving sites, a status fundamentally owed to Chang'an's role as the "political core" during the Han and Tang dynasties. As a hub for incoming Sogdian caravans and envoys from the Western Regions, the high-ranking tombs in the Guanzhong area not only record the prosperity of the Silk Road but also profoundly portray scenes of the daily social integration of ethnic groups—such as *Hu* merchants, musicians, and polo players. Gansu and Ningxia, situated at the "throat of the Silk Road", feature numerous portrait bricks from the Wei and Jin dynasties in the Hexi Corridor that depict scenes of farming and grazing; these serve as visual snapshots of grassroots ethnic integration along the Silk Road. Qinghai has yielded coffin paintings with frontier characteristics featuring the Tubo and Tuyuhun peoples. Meanwhile, surviving tomb murals in Xinjiang are relatively scarce; imagery involving the Sogdians, Uyghurs, and Qiuci (Kucha) is predominantly concentrated in grotto murals.("Figure 7")

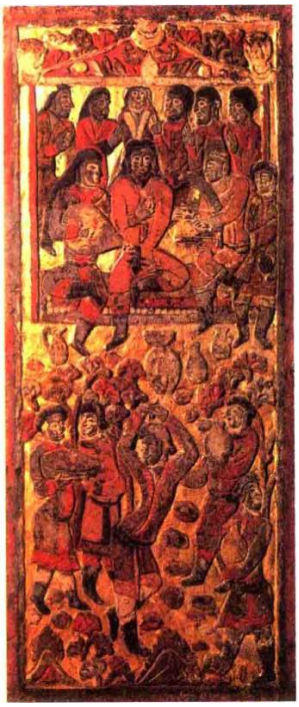


Figure 7 Sogdian caravan; the Tomb of An Jia, Northern Zhou Dynasty, Xi'an. [8]

3.3 The Central Region: Ritual Reconstruction amid Regime Change

The genesis of ethnic imagery in the Central region shifted from "Silk Road trade" to "regime succession and ritual reconstruction." Shandong leads with 62 surviving sites, a result of the proliferation of stone reliefs during the Han Dynasty's trend of lavish burials. Imagery such as "Hu-Han warfare" and "Hu presenting captives" serves, in essence, as symbolic representations of the Han Empire's construction of a universal order. Remains in Shanxi and Henan are concentrated during the Wei, Jin, and Northern Dynasties. The depictions of Xianbei guards and attendants found in the Northern Qi Xu Xianxiu Tomb in Taiyuan, the Northern Wei Shaling Tomb in Datong, and the Northern Wei Yuan Ye Tomb in Luoyang represent a "dual political declaration". These images signify the absorption of Central Plains ritual systems by minority regimes while simultaneously retaining their distinct ethnic characteristics. ("Figure 8")



Figure 8 Portrait stone from Wulaowa, east of Jiaxiang City, Shandong.[9]

3.4 The Northeast Region: Nomadic-Centric Single-Core Agglomeration

Inner Mongolia exhibits a high concentration with 65 surviving sites. As the birthplace of the Khitan and Mongol peoples, Liao Dynasty noble tombs—such as Tomb No. 6 at Kulun Banner and the Dishuihu Tomb—extensively depict nomadic life, including Khitan hairstyles (shaved heads), fur clothing, hunting, and banqueting. These representations constitute a self-affirmation and visual solidification of ethnic identity. In contrast, the provinces of Heilongjiang, Jilin, and Liaoning possess relatively few remains. This scarcity is attributed to the southward shift of the political center of the Liao and Jin dynasties to the Yan-Yun region, combined with technical constraints on mural construction imposed by the climate. ("Figure 9")



Figure 9 Khitan figures. Mural from Tomb No. 1 of the Liao Dynasty at Kulun Banner, Inner Mongolia Autonomous Region.

3.5 The Southwest and East Regions: Geographic Isolation and Transformation of Funerary Paradigms

In the Southwest, topographical isolation created by basin terrain caused funerary imagery to focus on indigenous immortal beliefs and manor life, with only sporadic examples of "Hu" portrait bricks remaining. Although the East region reached its economic and cultural zenith after the Song Dynasty, the trend of "modest burial" influenced by Cheng-Zhu Neo-Confucianism shifted the focus of funerary culture to above-ground stone carvings and bricks. Consequently, elements of the Maritime Silk Road trade rarely translated into figurative imagery within tomb chambers. The absence of such imagery in the East does not imply a lack of ethnic contact; rather, Jiangnan civilization adopted a distinct, non-visual funerary language to engage with the external world.("Figure 10")



Figure 10 Southwest region: Brick-chambered Tomb M1 of the Eastern Han to Shu Han period, Dalu Mountain, Jiangjin District, Chongqing.

4. DIACHRONIC EVOLUTION (HAN DYNASTY TO QING DYNASTY)

The advancement of human civilization is inextricably interwoven with the evolution of social systems, with diverse socio-ecological cultures nurturing and driving the course of this civilizational development. By focusing on the imagery of multi-ethnic integration in tomb murals, we can observe a consistent and orderly transmission within the evolutionary trajectory of this art form.("Figure 11" "Figure 12")

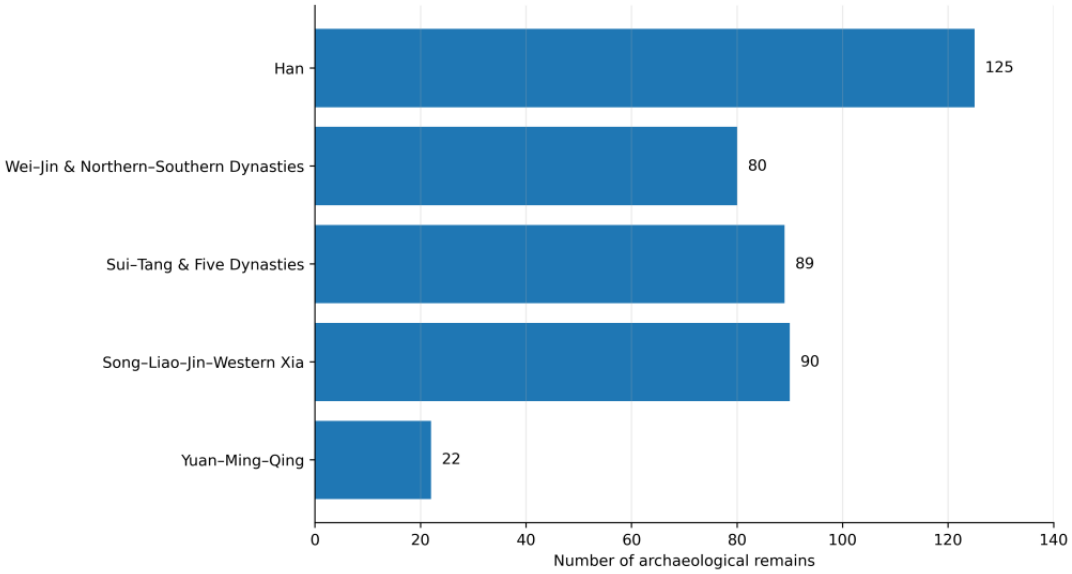


Figure 11 Chronological distribution of ancient ethnic imagery in Chinese tomb murals.

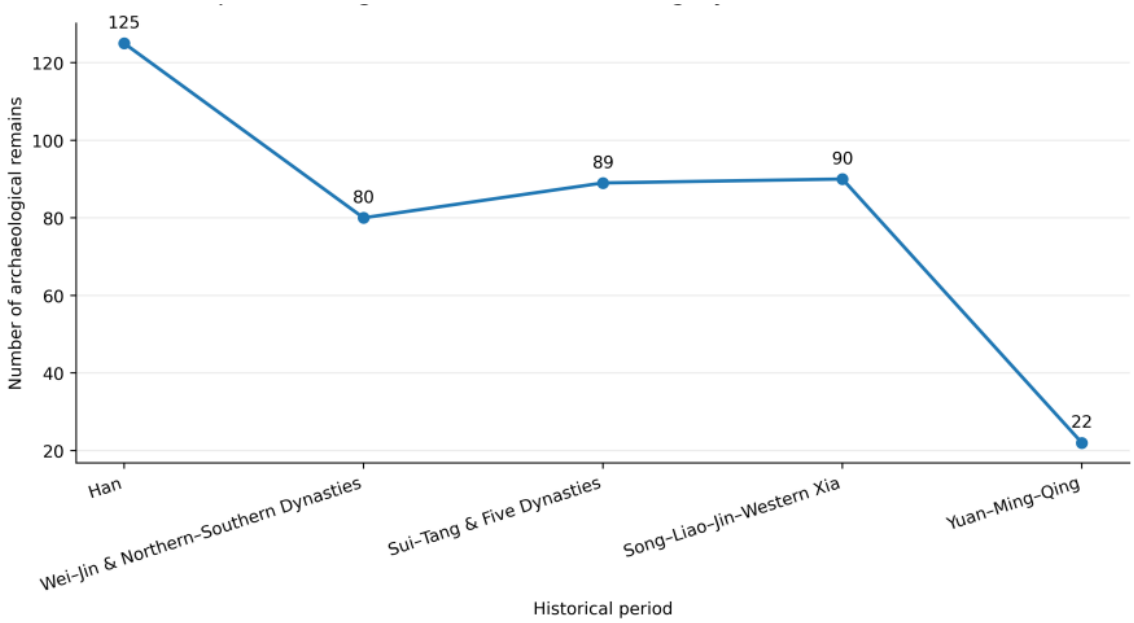


Figure 12 Temporal change in ancient ethnic imagery in Chinese tomb murals.

4.1 The Han Dynasty: A High Baseline and the "Gaze of the Other"

The imagery of multi-ethnic integration in tomb murals emerged at a remarkably high baseline during the Han Dynasty. Among the 406 surviving tomb sites, identifiable images exist of the *Hu*, Xiongnu, Baiyue, Wuhuan, Qiang, and Xianbei peoples. The Han Dynasty represented the pinnacle of the lavish burial tradition in the Central Plains. Guided by the funerary concept of "treating the dead as if they were living," multi-ethnic imagery—depicting scenes such as *Hu*-Han warfare, tributary missions from vassal states, *Hu* leading camels, and music and dance performances—ranked first in quantity, accounting for 32.22% of the total surviving remains. However, the imagery during this period remained in a stage of the "gaze of the other". Contingent upon the political backdrop of the Han Empire's territorial expansion and the opening of the Silk Road, images of the *Hu* peoples frequently served as foils to the majesty of the Great Han. They were presented either as exotic spectacles or as symbols of the conquered, having not yet penetrated the core of the social order of the Central Plains.

4.2 The Wei, Jin, and Northern and Southern Dynasties: The First Peak and the Inversion of Power

During this period, the proportion of multi-ethnic integration imagery reached its initial peak (45.45%), dominated primarily by Xianbei imagery. Although the total number of tombs decreased sharply and the practice of lavish burial declined, the proportion of ethnic imagery within the surviving tombs increased dramatically. As the patrons of the regimes were predominantly Xianbei nobles or Han individuals who were highly assimilated into nomadic culture, imagery such as Xianbei warriors and *Hu* music and dance was no longer viewed as an exotic spectacle. Instead, it became a direct visual symbol employed by the ruling class to proclaim political legitimacy. This peak in ratio essentially maps the inversion of political power. Xianbei and Sogdian imagery facilitated the introduction of Zoroastrian elements from the murals into the Huaxia (Chinese) civilizational system.

4.3 The Sui, Tang, and Five Dynasties: The Second Peak and Symbiosis in Daily Life

The proportion of imagery reached a second peak (43.2%), characterized by the emergence of *Hu* figures fulfilling diverse social functions. This marks a transition of integration from the

"display of political power" seen in the Wei and Jin dynasties to "daily symbiosis at the socio-economic level." *Hu* merchants, musicians, and camel drivers acted as integral cogs in the social machinery, embedding themselves into the daily lives of the Tang people. The shift of ethnic imagery from "grand narratives" to "secular life" represents the deepest manifestation of cultural fusion.

4.4 The Song, Liao, Jin, and Xixia: Institutional Segregation and the "Visual Retreat" of Imagery

During this period, the proportion of remains dropped to 21.79%. Under the influence of Song Neo-Confucianism, tomb practices underwent a "purging of *Hu* styles," reinforcing the boundary between the Hua (Chinese) and Yi (non-Chinese) peoples. The Liao Dynasty exhibited a "binary juxtaposition," utilizing a Han institutional framework to contain Khitan imagery. In the Jin Dynasty, both underground murals and above-ground stone statuary trended toward comprehensive Sinicization, causing ethnic traits to dissolve. Conversely, the Xixia Dynasty presented a "dual structure": underground coffin paintings depicted multi-ethnic coexistence, while above-ground mausoleums underwent Tangutization. The visual strategies employed by these regimes—whether defensive, juxtaposed, assimilative, or transformative—profoundly reflect a shift in the morphology of ethnic integration, evolving from the "daily symbiosis" of the Tang era to "institutional segregation" and "performative proclamation".

4.5 The Yuan, Ming, and Qing Dynasties: Deliberate Reinforcement under Secret Burial Constraints

The proportion stands at 34.38%, dominated by imagery of Mongol-Han interaction from the Yuan Dynasty. Due to the Mongol custom of secret burial, there are few identifiable Mongol mural tombs; consequently, existing Yuan remains featuring Mongol-Han imagery may belong to Han patrons, a subject of ongoing academic debate. In cases such as the Yuan Tomb at Dong'er Village in Pucheng, Shaanxi, the tomb owners—depicted wearing Mongol-style attire—deliberately commissioned scenes of Mongols and Han people banqueting together in the underground space. This represents an emphasis on multi-ethnic identity despite the constraints of funerary customs, as well as an expression of political allegiance to a multi-ethnic empire.

In summary, imagery of multi-ethnic interaction has continuously appeared within tomb spaces since the Han Dynasty, persisting through dynastic transitions without interruption. The phased evolution from the "gaze of the other" to "power declaration", "daily symbiosis", "institutional segregation", and finally "identity reinforcement", methodically demonstrates the historical depth and vitality of the pattern of "diversity in unity" of the Chinese nation.

5. DIGITAL NARRATIVE STRATEGIES: FROM STATIC IMAGES TO DYNAMIC PRESENTATION

As underground archaeological materials, murals constitute a precious cultural heritage. In the era of digital intelligence, the dynamic and vitalized presentation of murals has become a significant direction for cultural heritage preservation and transmission. On the one hand, the image data obtained through research can be systematically organized and visualized to support mural conservation, as exemplified by national pioneering digitization projects such as the Dunhuang murals. On the other hand, mural imagery can be revitalized for public display, such as immersive interpretations of murals in museums and exhibitions, which extend the narrative depth across multiple dimensions, thereby awakening murals that have slumbered for a millennium and creating a convergence of past and present.

5.1 Spatial Narrative: Visualized Mapping through Geographic Information Systems

Through a WebGIS platform, image data can be integrated with historical geographical information to create a "Spatio-temporal Atlas of Ethnic Interaction Imagery in Ancient China". By sliding along a timeline and zooming across space, audiences can intuitively perceive the dynamic processes of ethnic migration and cultural integration.

5.2 Semantic Narrative: Image Ontology and Knowledge Graphs

A knowledge graph of ethnic imagery can be constructed to establish associations among ethnic

figures, costumes, artifacts, and scenes from the same period—for instance, linking "camels", "*Hu* figures", and "trade"—thereby revealing the profound cultural networks underlying the imagery. Furthermore, comparative analysis of the same ethnic group across different periods can be attempted to trace their temporal transformations.

5.3 Immersive Narrative: 3D Reconstruction and Interactive Scenes

Taking representative tombs—such as the Tomb of Crown Prince Zhanghuai and the Tomb of An Jia—as core case studies, 3D modeling and VR/AR technologies can be employed to reconstruct the funerary chamber spaces. This approach restores murals from "planar slices" into "three-dimensional spaces," encompassing the social contexts and the daily life—clothing, food, housing, and transportation—of various ethnic groups, thereby enabling audiences to gain an immersive experience of the multi-ethnic visual culture within ancient tombs.

A pioneering example is the VR large-space immersive experience project *Beyond the Murals: The Tang Dynasty*, launched by the Shaanxi History Museum. Based on the murals of the Tomb of Crown Prince Zhanghuai, the project integrates VR large-space algorithms, 12K ultra-high-definition sampling, AI-powered 3D reconstruction, and intelligent gesture interaction technologies, transforming precious murals such as the *Polo Game* and the *Envoys* from static exhibits into enterable and interactive immersive historical scenes. Viewers "step into the painting" from the perspective of Li Shouli, the son of Crown Prince Zhanghuai: they can personally witness the polo players in the *Polo Game* wielding their mallets, encounter the court ladies in *Observing Birds and Catching Cicadas*, and even "approach" the foreign envoys in diplomatic scenes. The grand Tang vision of *Hu*-Han coexistence depicted in these murals is thus transformed into a tangible historical site.

A further exemplary case is the Northern Zhou Tomb of An Jia in Xi'an. The scenes carved on its funerary couch—depicting the Sogdian *sabao*'s journeys, banquets, hunting expeditions, and Zoroastrian rituals—constitute dual testimony to the Central Asian communities in China "retaining their native customs while integrating into the Han institutional order." The narrative content of these couch reliefs can be re-presented through digital storytelling: through 3D reconstruction restoring the tomb's original context, the life story of the *sabao* can be enacted, allowing audiences to intuitively perceive how Sogdian merchants, within the Central Plains architectural form of the domed brick chamber tomb, perpetuated their own faith and living memories through the reliefs on a stone couch—a microcosm of ethnic integration within funerary space.

The viability of such immersive interpretation has been validated by projects including the *Wandering in Dunhuang* digital exhibition hall and the *Digital Library Cave*. The latter, a collaboration between the Dunhuang Academy and Tencent, employs 3D modeling, AI-based character recognition, image conflation, and knowledge graphs to recreate the Library Cave, aggregating over 9,900 manuscripts and more than 60,700 images. The *Wandering in Dunhuang* immersive exhibition, through 3D modeling, game-engine rendering, and large-space VR interaction, recreates the mural scenes of Cave 285 at Dunhuang and has received over 80,000 visitors to date—demonstrating the feasibility of scaled promotion of this approach.

6. CONCLUSION

Through a data-driven analysis of ethnic imagery in more than 406 tomb mural remains spanning the Han to Qing dynasties, this study arrives at the following core conclusions:

First, the spatio-temporal distribution of ethnic integration imagery exhibits clear patterns. Spatially, it presents a non-equilibrium configuration of being "dense in the west and sparse in the east, and heavy in the north and light in the south." The formation of the three major agglomeration zones—Shaanxi, Shandong, and Inner Mongolia—resulted from the combined effects of geopolitics, Silk Road trade, and funerary traditions, rather than the natural attenuation of artistic dissemination. Temporally, ethnic imagery underwent a five-stage evolution—"the gaze of the other," "declaration of power," "daily symbiosis," "institutional segregation," and "identity reinforcement"—persisting without interruption over two millennia. These findings demonstrate that multi-ethnic integration was neither a localized nor a period-specific phenomenon, but a continuous process throughout Chinese history. Tomb murals thus constitute a quantifiably verifiable visual chronicle of ethnic integration.

Second, the transformation of imagery forms maps the progressive deepening of integration. From the symbolic representation of *Hu* figures as "foils to imperial majesty" in the Han Dynasty, to the daily embeddedness of *Hu* merchants and musicians as structural social roles in the Sui and Tang dynasties, to the fusion of Xianbei institutions in the Wei, Jin, and Northern and Southern Dynasties, and further to the conscious depiction of multi-ethnic scenes in Liao and Yuan tombs, the shift in the subjectivity of the imagery indicates that integration gradually descended from the political surface level of "other-narrative" to the levels of life and identity—a "self-narrative." The formation of the pattern of "diversity in unity" of the Chinese nation thus left a clear evolutionary trajectory in underground imagery.

Third, digital technologies can activate the contemporary value of static images. This study validates the feasibility of a three-tiered narrative framework of "spatio-temporal atlas—knowledge graph—immersive restoration." Quantitative methods transcend the fragmentary limitations of traditional case studies, while digital narrative translates academic conclusions into communication products perceivable by the public, thereby completing a full closed loop from "data revealing patterns" to "narrative conveying identity."

Ultimately, this study demonstrates that ethnic imagery in tomb murals serves both as testimony to history and as a renewable cultural resource. Revealing the reality of integration through data, and perpetuating its spirit through narrative, constitutes an effective pathway by which the digital humanities can serve both the historical interpretation and the contemporary construction of the Chinese national community.

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